SUPPLEMENTARY SOILS INVESTIGATION
KAOPA SUBDIVISION UNIT 3B
KAILUA, OAHU, HAWAII
for
LONE STAR HAWAII, INC.

W.O. 176-B

May 24, 1974

ERNEST K. HIRATA & ASSOCIATES, INC.

SUPPLEMENTARY SOILS INVESTIGATION
KAOPA SUBDIVISION UNIT 3B
KAILUA, OAHU, HAWAII

INTRODUCTION

The following report presents the results of our supplementary soils investigation conducted on the subject property. A preliminary grading plan prepared by Sunn, Low, Tom, & Hara, Inc. is enclosed in the Appendix showing the approximate location of all borings drilled within the proposed development. The purpose of this investigation was to refine our settlement data predictions and to determine the general subsurface soil conditions per our addendum #2 to the Soils and Feasibility Investigation dated February 22, 1974.

PROPOSED GRADING AND DEVELOPMENT

The preliminary grading plan proposes filling into the lake a distance of 125 feet along Keolu Drive between sta. 50 + 10.6 to sta. 70 + 17.2. The proposed fill will slope from the present grades along Keolu Drive down to elevation +6 at the lakeside.

A reinforced earth wall is proposed along the entire length bordering the lake to retain the compacted fill.

Upon completion of grading, wood frame residential homes are proposed. The homes will be of post and beam construction.

FIELD EXPLORATION

Field exploration was performed between April 4 and May 1, 1974 by drilling four supplementary test borings along the existing berm. The approximate location of the borings are shown on the preliminary grading plan.

The soils were continuously logged by our field engineer and classified by visual examination in accordance with the Unified Soil Classification System.

Undisturbed samples were obtained at frequent intervals. Samples were obtained by driving a 3 inch O.D. split tube sampler with a 140 pound hammer from a height of 30 inches. The required blow count for each 6 inches of penetration are shown on the Boring Logs found in the Appendix designated Plates A1 through A8.

SOIL CONDITIONS

Results from the supplementary borings confirm our previous investigation that the soils underlying the site vary from soft and loose clayey silts and sand silt mixtures to medium dense silty clays. A longitudinal cross section is presented on Plate 1 in the Appendix indicating the subsurface soil profile.

CONCLUSIONS AND RECOMMENDATIONS

Although the subsurface soil conditions are variable, it is our opinion that the site can be developed provided proper construction procedures and sufficient time is allowed to permit consolidation of the soft deposits.

Time rate consolidations were taken of the subsurface materials. Our calculations indicate that total settlements may range from $2\frac{1}{2}$ to 8 inches at the proposed reinforced earth wall. We understand that these settlements can be safely taken by the reinforced earth wall. Total settlements of $7\frac{1}{2}$ to $11\frac{1}{2}$ inches can be anticipated along Keolu Drive. The bulk of the settlement will occur within the first two years of construction. These settlement predictions were based on the assumption that the soft clayey silts in the upper 3 to 4 feet will be removed.

Slope stability analysis was calculated for a typical section along the lakefront, and a factor of safety in excess of 1.5 was obtained.

Field and laboratory testing was conducted by personnel of Jorgensen Steel Company to determine the soil resistivity and pH of the proposed backfill material for the reinforced earth wall. In addition, the pH value of the lake water was determined in the field.

The backfill material tested was obtained from the Kailua Heights Subdivision Unit 8B. Results of the testing indicate that the material has a pH value of 7.3 with a soil resistivity of 3450 ohms per cubic centimeter. The lake water was tested at three different locations with pH values ranging from 4.8 to 6.8.

We recommend that prior to any filling, the upper 3 to 4 feet of soft clayey silt be removed and wasted from the site. Then during filling operations, settlement markers should be placed at intervals of approximately 200 feet in order to monitor the anticipated settlement. All fill placed above the water table should be compacted to a minimum of 90 percent relative compaction.

Respectfully submitted,

Ernest K. Hirata & Associates, Inc.

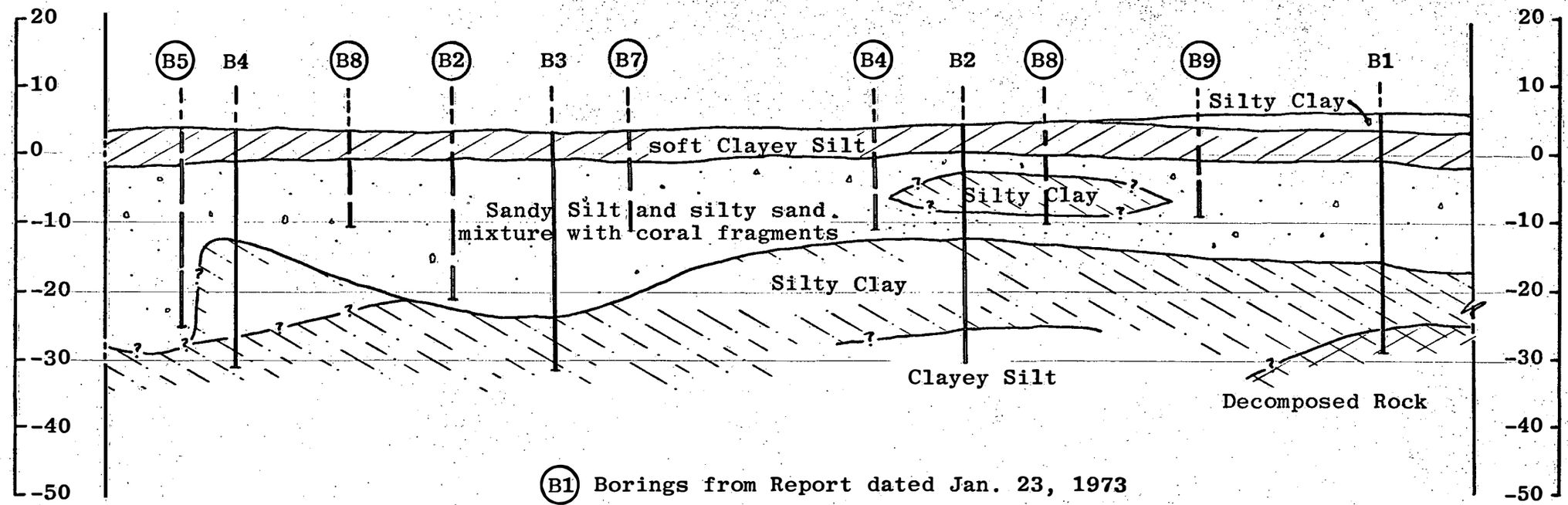
Ernest K. Hirata

Ernest K. Hirata P.E. 2732

Encl: Longitudinal Cross Section Plate 1
Log of Borings Plates A1 through A8
Consolidation Test Report Plates B1 through B11
Preliminary Grading Plan

EKH:ph

LONGITUDINAL CROSS SECTION



(B1) Borings from Report dated Jan. 23, 1973

B1 Borings from Supplementary Report

0 200 400 600 800 1000 1200 1400 1600 1800 2000

SCALE: Horiz. 1" = 200'
Vert. 1" = 20'

W.O. 176-B

Plate 1

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Soils and Foundation Engineering
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BORING LOG

BORING NO. B1 DRIVING WT. 140 lbs. DATE OF DRILLING 4-4-74

SURFACE ELEV. + 6.0 ± DROP 30 in. W. O. 176-B

DEPTH FEET	CORE	BAG	PENETRATION RESIST. BLOWS/6 inches	DRY DENSITY PCF	MOISTURE CONTENT %	RELATIVE COMPACTION %	DIRECT SHEAR STRENGTH PARAMETERS ∅	DIRECT SHEAR STRENGTH PARAMETERS C	CLASSIFICATION (% Sand, % Silt, % Clay)
0									Silty CLAY (MH) - Grayish brown, soft, very moist.
▽	x		2 3 4	60.0	72.0				Clayey SILT (OL) - Dark gray, soft to firm.
5	x		2 2 3	58.3	68.4				
	x		2 0 1	62.3	60.0				Sandy SILT (ML) - Light brown, soft, mixed with clay and coral fragments. Grading to gray color from 9 feet.
10									
15	x		1 1 1	53.3	85.7				
	x		1 1 1	54.4	77.5				
20									
	x		8 7 10	63.8	60.8		16.5°	0.02 KSF	Silty CLAY (MH) - Mottled gray, medium stiff, with coral fragments.
25									
	x		5 5 13	40.2	115.6				
30									Plate A1

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BORING LOG

BORING NO. B1 (cont.) DRIVING WT. 140 lbs. DATE OF DRILLING 4-4-74

SURFACE ELEV. + 6.0 ± DROP 30 in. W.O. 176-B

DEPTH FEET	CORE	BAG	PENETRATION RESIST. BLOWS/6 inches	DRY DENSITY PCF	MOISTURE CONTENT %	RELATIVE COMPACTION %	DIRECT SHEAR STRENGTH PARAMETERS Ø	DIRECT SHEAR STRENGTH PARAMETERS C	CLASSIFICATION (% Sand, % Silt, % Clay)
-30									Decomposed Rock - Clayey Silt, mottled brown, stiff.
	x		17 36 36	81.8	40.8				
-35									End Boring at 35 feet. ▽ Water level at 40 feet.
-40									
-45									

Plate A2

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BORING LOG

BORING NO. B2 DRIVING WT. 140 lbs. DATE OF DRILLING 4-17-74

SURFACE ELEV. 4.5 ± DROP 30 in. W.O. 176-B

DEPTH FEET	CORE	BAG	PENETRATION RESIST. BLOWS/6 inches	DRY DENSITY PCF	MOISTURE CONTENT %	RELATIVE COMPACTION %	DIRECT SHEAR STRENGTH PARAMETERS ø	DIRECT SHEAR STRENGTH PARAMETERS C	CLASSIFICATION (% Sand, % Silt, % Clay)
0									Clayey SILT (OL) - Black, very moist, soft, organic.
	x		3 6 9	58.2	111.4				
5	x		5	78.4	61.2				Sandy SILT (ML) - Gray, wet, soft and loose with coral fragments.
	x		3 4 5	82.3	38.9				Silty CLAY (MH) - Yellowish brown, firm to medium stiff.
10	x		9 6 8	73.7	61.9		UNCONFINE 2498 PSF		
	x		2 4 4	75.5	47.5				Sandy SILT (ML) - Yellowish gray, firm to medium stiff with coral fragments.
15									
20	x		9 9 7 9 10	74.8	48.8		UNCONFINE 3398 PSF		Silty CLAY (MH) - Yellowish brown, medium stiff. Grading to gray brown color from 20 feet.
25	x		7 12 15	65.5	59.8				
30									Plate A3

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BORING LOG

BORING NO. B2 (cont.) DRIVING WT. 140 lbs. DATE OF DRILLING 4-17-74

SURFACE ELEV. + 4.5 ± DROP 30 in. W.O. 176-B

DEPTH FEET	CORE	BAG	PENETRATION RESIST. BLOWS/6 inches	DRY DENSITY PCF	MOISTURE CONTENT %	RELATIVE COMPACTION %	DIRECT SHEAR STRENGTH PARAMETERS Ø	DIRECT SHEAR STRENGTH PARAMETERS C	CLASSIFICATION (% Sand, % Silt, % Clay)
30	x		13 19 40	70.0	49.5				Clayey SILT (ML) - Dark gray, stiff.
	x		19 32 50/4.5"	65.7	57.0				
35									End boring at 35 feet. ▽ Water level at 2.5 feet.
40									
45									

Plate A4

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BORING LOG

BORING NO. B3 DRIVING WT. 140 lbs. DATE OF DRILLING 5-3-74

SURFACE ELEV. + 3.7 ± DROP 30 in. W.O. 176-B

DEPTH FEET	CORE	BAG	PENETRATION RESIST. BLOWS/6 inches	DRY DENSITY PCF	MOISTURE CONTENT %	RELATIVE COMPACTION %	DIRECT SHEAR STRENGTH PARAMETERS ø	DIRECT SHEAR STRENGTH PARAMETERS C	CLASSIFICATION (% Sand, % Silt, % Clay)
0									Clayey SILT (OL) - Mottled dark gray, moist, soft, organic.
▽	x		push push 1	26.7	213.5				
5	x		push 1 push push 1	65.6	57.5				Sandy SILT (ML) - Gray, very loose and soft with coral fragments.
10	x		1 push 1 push	56.5	76.4		13°	0.32 KSF	
15	x		1 push 3	59.4	62.6				
20	x		1 push 2 push	52.5	81.8				
25	x		2 2 6	82.0	56.4				
30	x		4 3 5	No Recovery					Silty CLAY (MH) - Brown, firm.

Plate A5

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BORING LOG

BORING NO. B3 (cont.) DRIVING WT. 140 lbs. DATE OF DRILLING 5-3-74

SURFACE ELEV. +3.7 ± DROP 30 in. W.O. 176-B

DEPTH FEET	CORE	BAG	PENETRATION RESIST. BLOWS/6 inches	DRY DENSITY PCF	MOISTURE CONTENT %	RELATIVE COMPACTION %	DIRECT SHEAR STRENGTH PARAMETERS Ø	DIRECT SHEAR STRENGTH PARAMETERS C	CLASSIFICATION (% Sand, % Silt, % Clay)
30									
	x		3 5 5	55.7	99.0		32.5°	0.34 KSF	
35									End boring at 35 feet. ▽ Water level at 1.7 feet.
40									
45									

Plate A6

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BORING LOG

BORING NO. B4 DRIVING WT. 140 lbs. DATE OF DRILLING 5-1-74

SURFACE ELEV. + 3.7 ± DROP 30 in. W.O. 176-B

DEPTH FEET	CORE	BAG	PENETRATION RESIST. BLOWS/6 inches	DRY DENSITY PCF	MOISTURE CONTENT %	RELATIVE COMPACTION %	DIRECT SHEAR STRENGTH PARAMETERS Ø	DIRECT SHEAR STRENGTH PARAMETERS C	CLASSIFICATION (% Sand, % Silt, % Clay)
0									
	x		1 1 1	27.3	189.5				Clayey SILT (OL) - Black, very moist, soft, organic, with some coral fragments.
5	x		4 2 4	77.9	44.8				Sandy SILT (ML) - Gray, loose and soft with finger coral fragments.
	x		push push 3 4	60.8	64.2				
10	x		push 1 push 1						
15									
	x		4 3 4	63.7	53.8		25.7°	0.49 KSF	Silty CLAY (MH) - Yellowish brown, firm to medium stiff.
20									Grading to tan color from 20 feet.
	x		5 4 6	82.9	33.2				
25									
	x		6 4 5	79.5	43.2				
30									Plate A7

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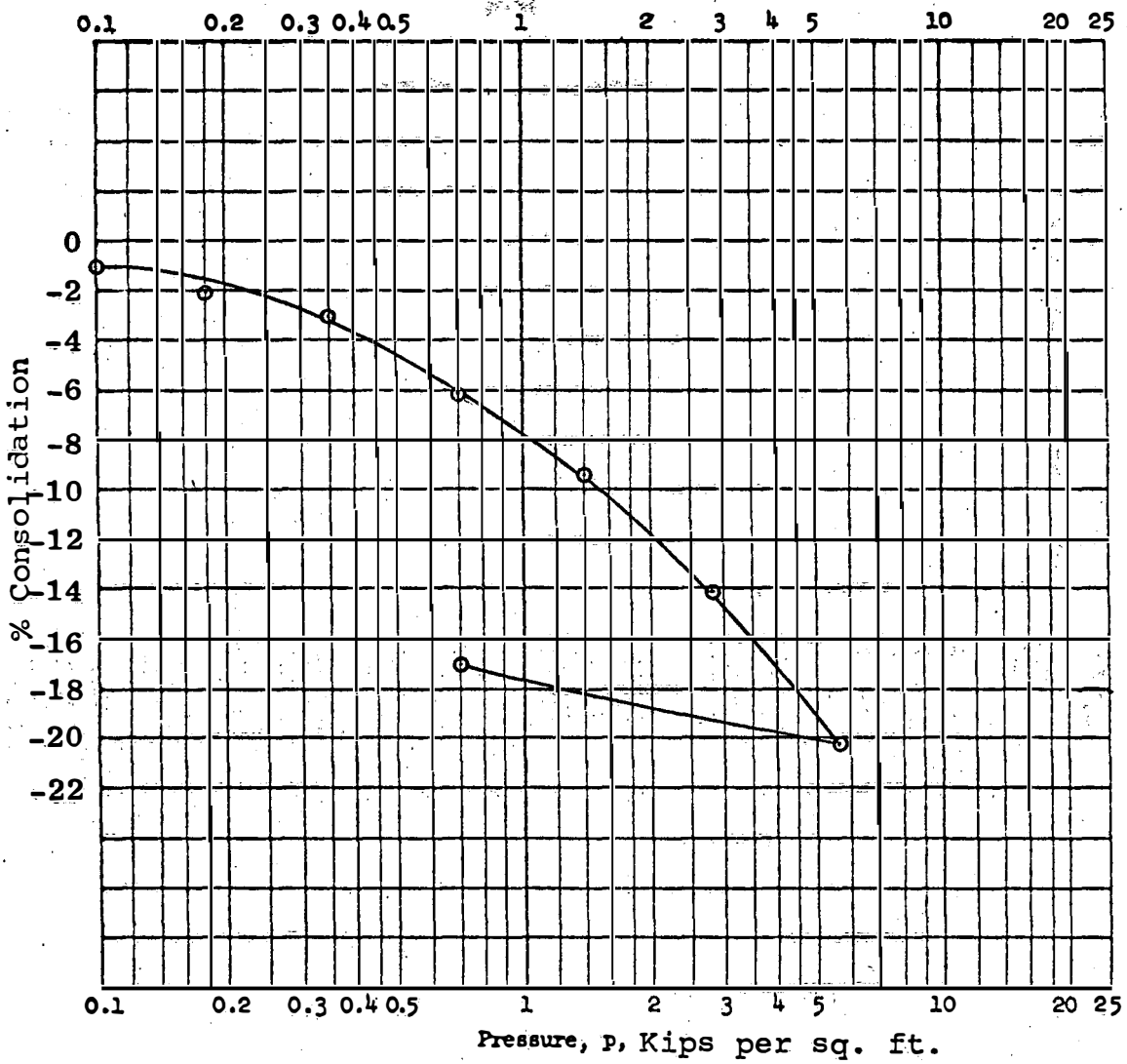
BORING LOG

BORING NO. B4 (cont.) DRIVING WT. 140 lbs. DATE OF DRILLING 5-1-74

SURFACE ELEV. + 3.7 ± DROP 30 in. W. O. 176-B

DEPTH FEET	CORE	BAG	PENETRATION RESIST. BLOWS/6 inches	DRY DENSITY PCF	MOISTURE CONTENT %	RELATIVE COMPACTION %	DIRECT SHEAR STRENGTH PARAMETERS Ø	DIRECT SHEAR STRENGTH PARAMETERS C	CLASSIFICATION (% Sand, % Silt, % Clay)
30									
	x		4 5 6	64.8	56.0				Grading to dark brown color from 34 feet.
35									End boring at 35 feet. ▽ Water level at 3.7 feet.
40									

Plate A8



Type of Specimen: Undisturbed		Before Test		After Test	
Diam 2.40 in.	Ht 1.0 in.	Water Content, w_o	68.4 %	w_f	63.1 %
Overburden Pressure, p_o	T/sq ft	Void Ratio, e_o		e_f	
Preconsol. Pressure, p_c	T/sq ft	Saturation, S_o	%	S_f	%
Compression Index, C_c		Dry Density, γ_d	58.3 lb/ft^3		
Classification OL		k_{20} at e_o =	$\times 10^{-}$ cm/sec		
LL	G_s				
PL	D_{10}				

Project: Kaopa Subdivision Unit 3B

Lone Star Hawaii, Inc.

Remarks: Water added at 700 PSF

Area: W.O. 176-B

Boring No. B1 Sample No.

Depth / El 6' Date 4-8-74

CONSOLIDATION TEST REPORT

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1 MAY 63

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Plate B1

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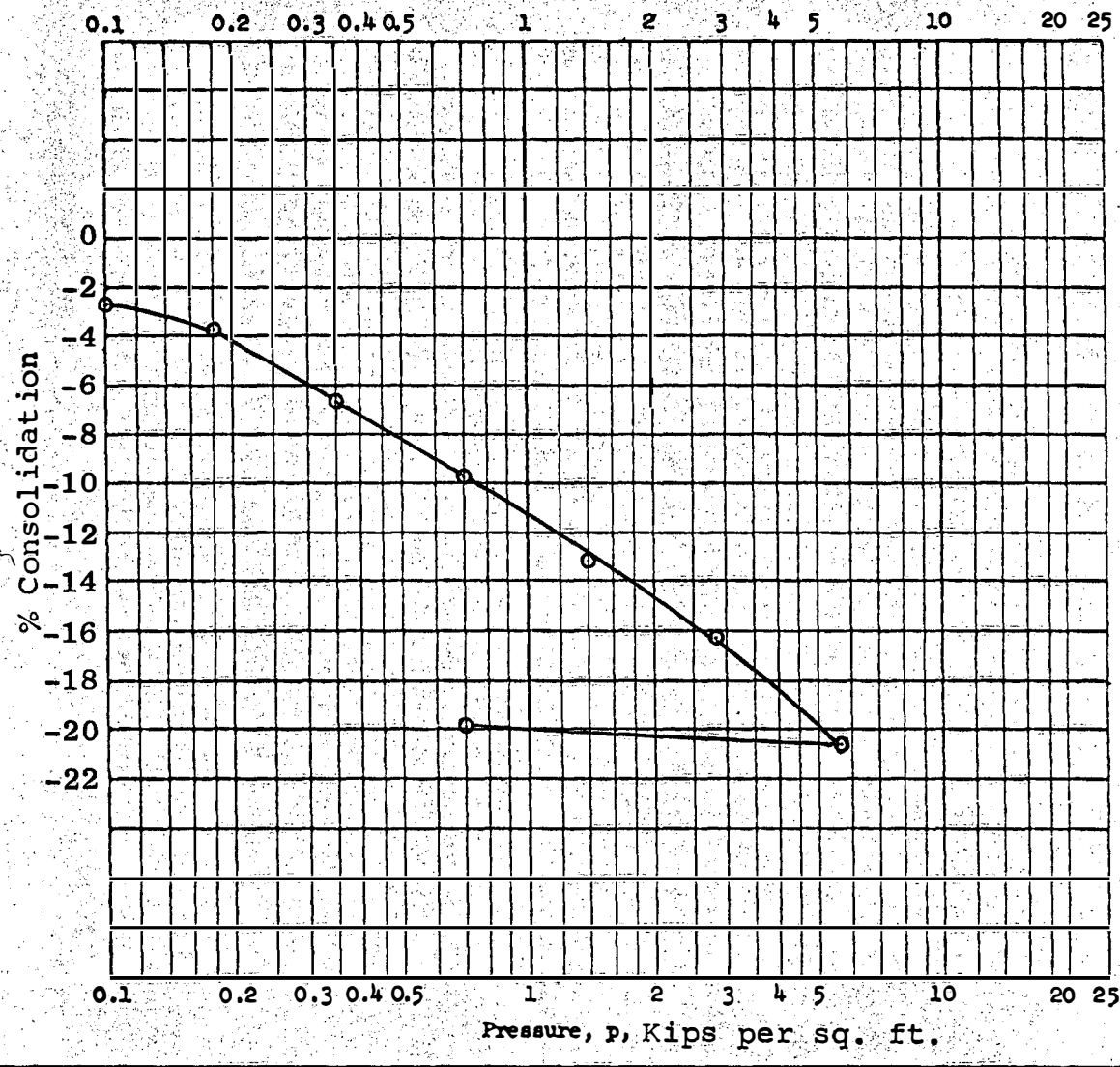

Type of Specimen: Undisturbed		Before Test		After Test	
Diam 2.40 in.	Ht 1.0 in.	Water Content, w_o	85.7 %	w_f	%
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o		e_f	
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	%	S_f	%
Compression Index, C_c		Dry Density, γ_d	53.3 lb/ft^3		
Classification ML		k_{20} at e_o =	× 10^{-} cm/sec		
LL	G_s	Project Kaopa Subdivision Unit 3B			
PL	D_{10}	Lone Star Hawaii, Inc.			
Remarks		Area W.O. 176-B			
		Boring No. B1	Sample No.		
		Depth / El 13'	Date 4-22-74		
		CONSOLIDATION TEST REPORT			

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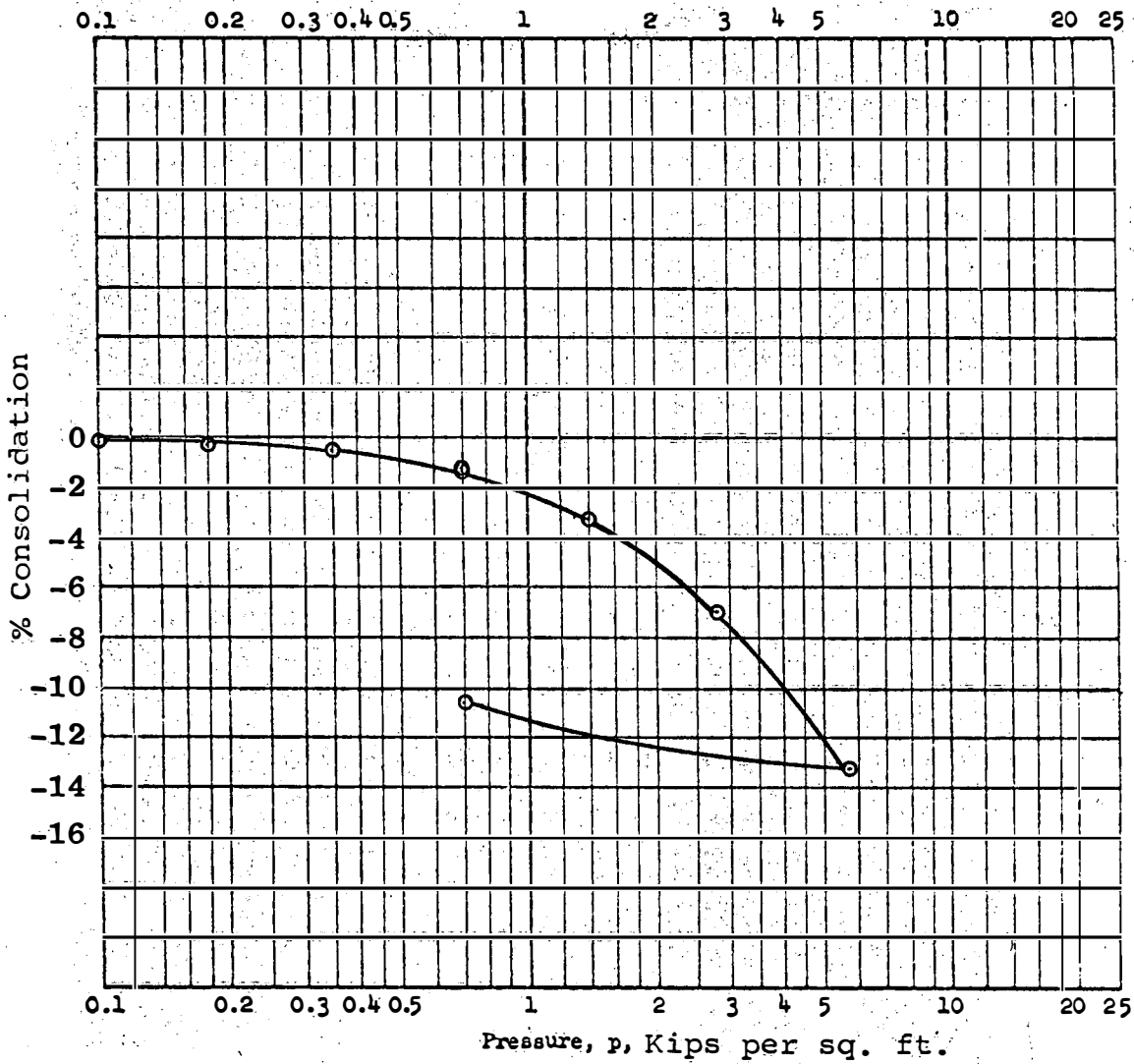
Plate B2



Type of Specimen	Undisturbed	Before Test		After Test	
Diam 2.40 in.	Ht 1.0 in.	Water Content, w_o	77.5 %	w_f	66.4 %
Overburden Pressure, p_o	T/sq ft	Void Ratio, e_o		e_f	
Preconsol. Pressure, p_c	T/sq ft	Saturation, S_o	%	S_f	%
Compression Index, C_c		Dry Density, γ_d	54.4 lb/ft^3		
Classification	ML	k_{20} at e_o =	× 10$^-$ cm/sec		
LL	G_s	Project	Kaopa Subdivision Unit 3B		
PL	D_{10}		Lone Star Hawaii, Inc.		
Remarks	Water added at 700 PSF	Area	W.O. 176-B		
		Boring No.	B1	Sample No.	
		Depth El	18'	Date	4-9-74
		CONSOLIDATION TEST REPORT			

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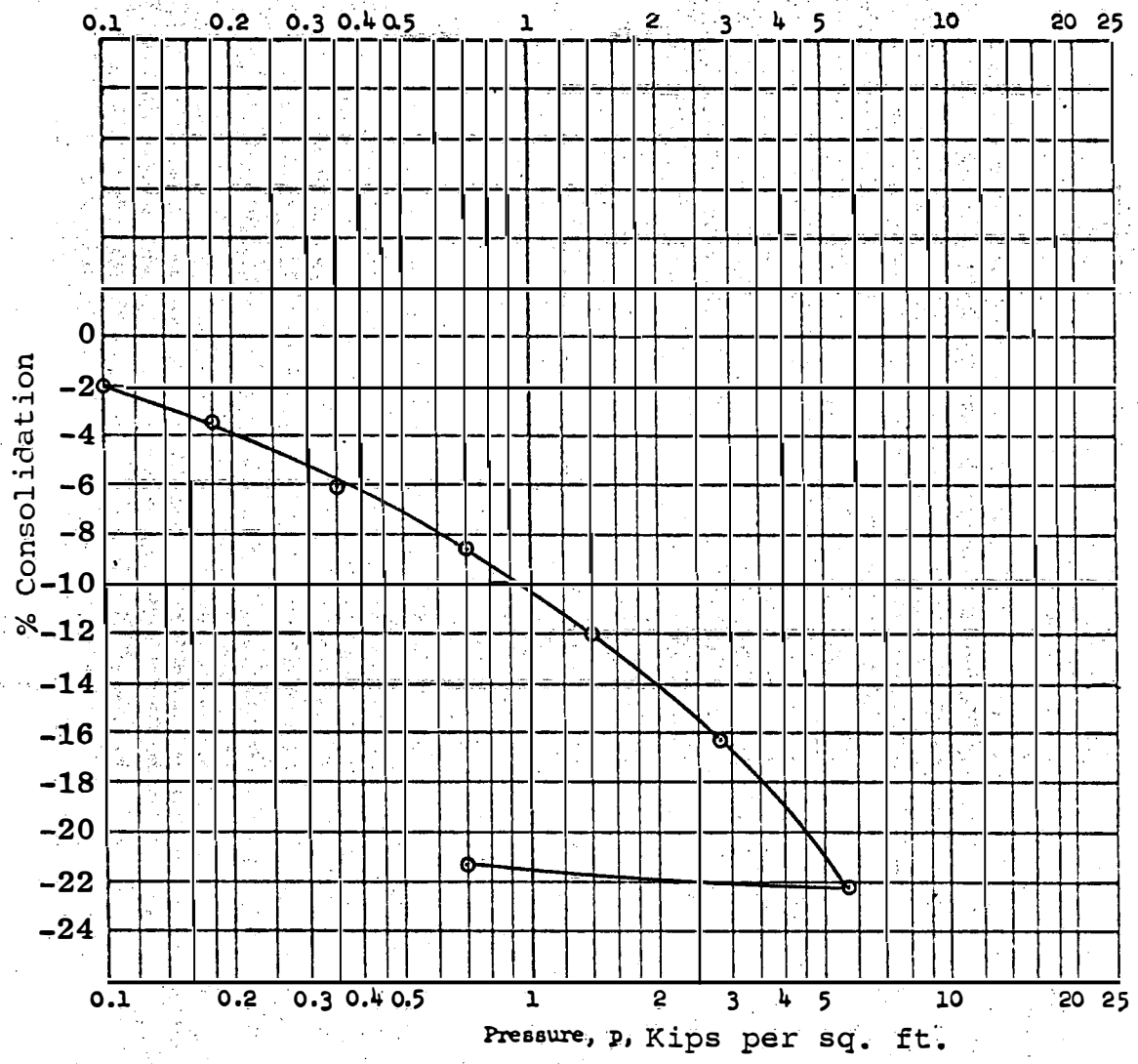
Plate B3



Type of Specimen: Undisturbed		Before Test		After Test	
Diam 2.40 in.	Ht 1.0 in.	Water Content, w_o	60.8 %	w_f	47.0 %
Overburden Pressure, p_o	T/sq ft	Void Ratio, e_o		e_f	
Preconsol. Pressure, p_c	T/sq ft	Saturation, S_o	%	S_f	%
Compression Index, C_c		Dry Density, γ_d	63.8 lb/ft^3		
Classification: MH		k_{20} at e_o =	x 10^{-} cm/sec		
LL	G_s	Project: Kaopa Subdivision Unit 3B			
PL	D_{10}	Lone Star Hawaii, Inc.			
Remarks: Water added at 700 PSF		Area: W.O. 176-B			
		Boring No. B1		Sample No.	
		Depth / El 23'		Date 4-5-74	
		CONSOLIDATION TEST REPORT			

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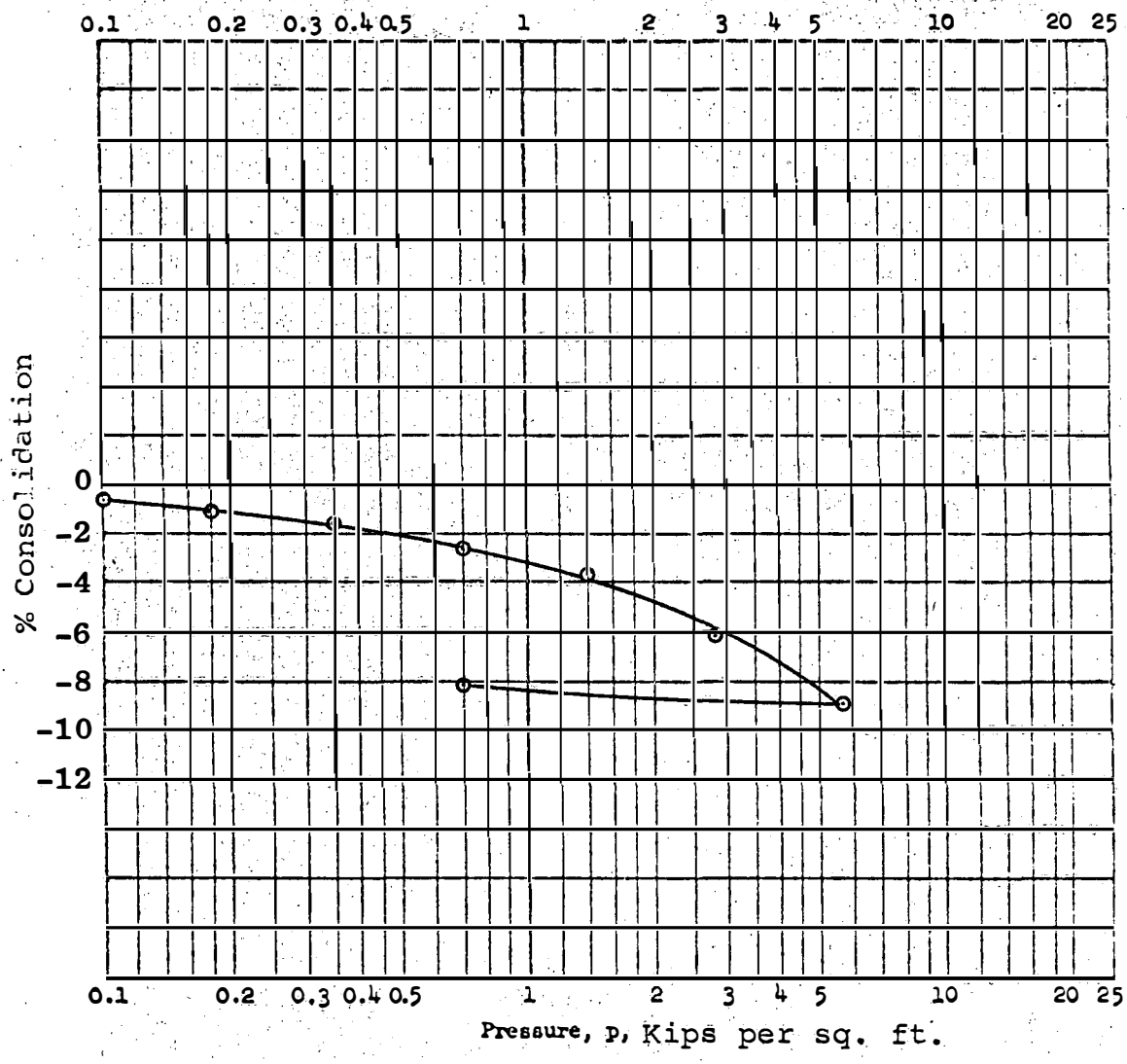
Plate B4



Type of Specimen	Undisturbed	Before Test		After Test	
Diam 2.40 in.	Ht 1.0 in.	Water Content, w_o	61.2 %	w_f	34.8 %
Overburden Pressure, p_o	T/sq ft	Void Ratio, e_o		e_f	
Preconsol. Pressure, p_c	T/sq ft	Saturation, S_o	%	S_f	%
Compression Index, C_c		Dry Density, γ_d	78.4 lb/ft^3		
Classification	ML	k_{20} at e_o =	× 10$^-$ cm/sec		
LL	G_s	Project	Kaopa Subdivision Unit 3B		
PL	D_{10}		Lone Star Hawaii, Inc.		
Remarks Water added at 700 PSF		Area	W.O. 176-B		
		Boring No.	B2	Sample No.	
		Depth El	6'	Date	4-21-74
		CONSOLIDATION TEST REPORT			

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Plate B5

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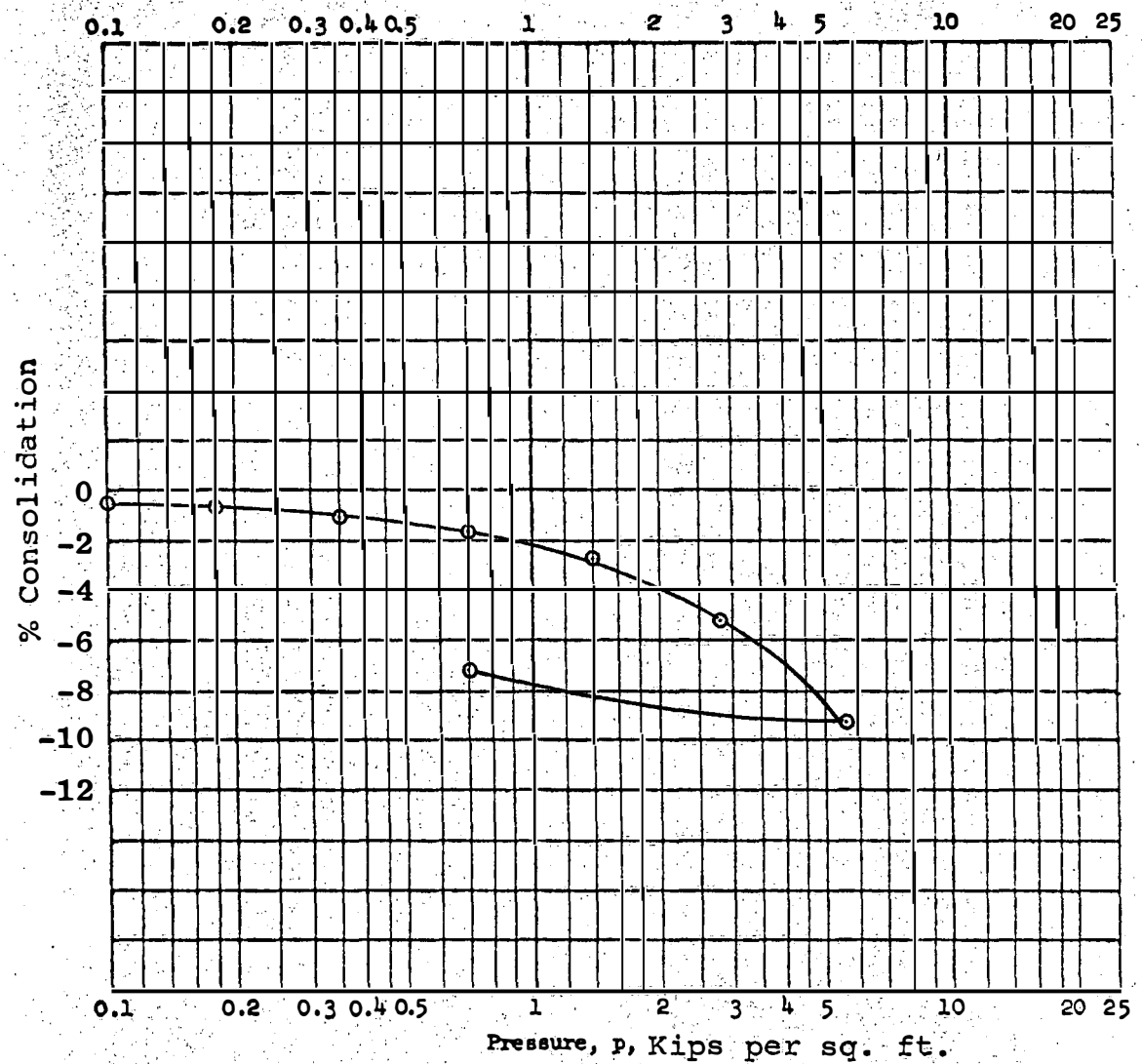

Type of Specimen: Undisturbed		Before Test		After Test	
Diam 2.40 in.	Ht 1.0 in.	Water Content, w_o	47.5 %	w_f	43.7 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o		e_f	
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	%	S_f	%
Compression Index, C_c		Dry Density, γ_d	75.5 lb/ft^3		
Classification ML		k_{20} at e_o =	x 10^{-} cm/sec		
LL	G_s	Project Kaopa Subdivision Unit 3B			
PL	D_{10}	Lone Star Hawaii, Inc.			
Remarks Water added at 700 PSF		Area W.O. 176-B			
		Boring No. B2		Sample No.	
		Depth / El 16'		Date 4-18-74	
		CONSOLIDATION TEST REPORT			

ENG FORM 2090
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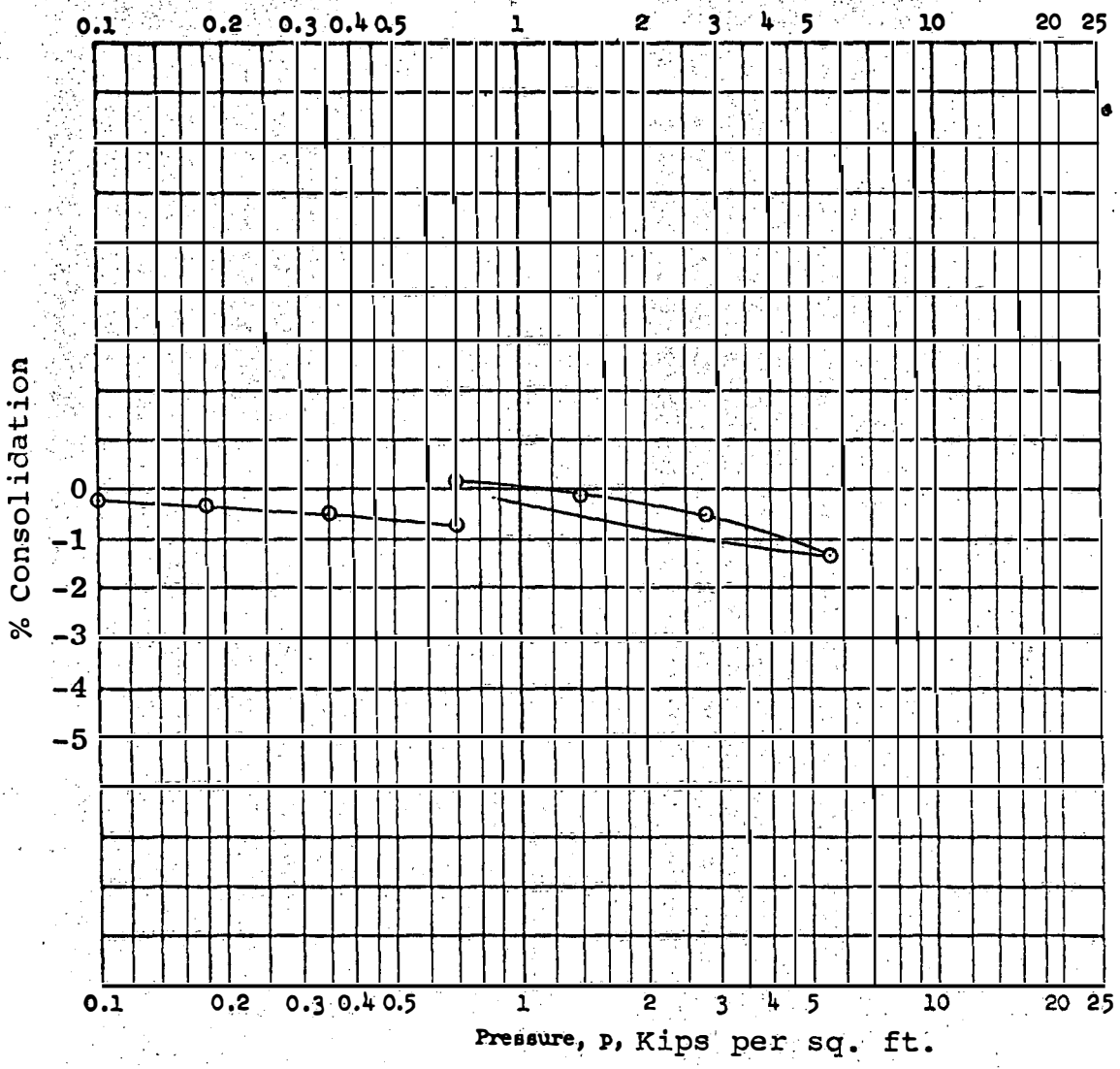
Plate B6



Type of Specimen	Undisturbed	Before Test		After Test	
Diam 2.40 in.	Ht 1.0 in.	Water Content, w_o	49.5 %	w_f	58.5 %
Overburden Pressure, p_o	T/sq ft	Void Ratio, e_o		e_f	
Preconsol. Pressure, p_c	T/sq ft	Saturation, S_o	%	S_f	%
Compression Index, C_c		Dry Density, γ_d	70.0 lb/ft^3		
Classification	ML	k_{20} at e_o =	x 10$^-$ cm/sec		
LL	G_s	Project	Kaopa Subdivision Unit 3B		
PL	D_{10}		Lone Star Hawaii, Inc.		
Remarks Water added at 700 PSF		Area	W.O. 176-B		
		Boring No.	B2	Sample No.	
		Depth El	30'	Date	4-22-74
		CONSOLIDATION TEST REPORT			

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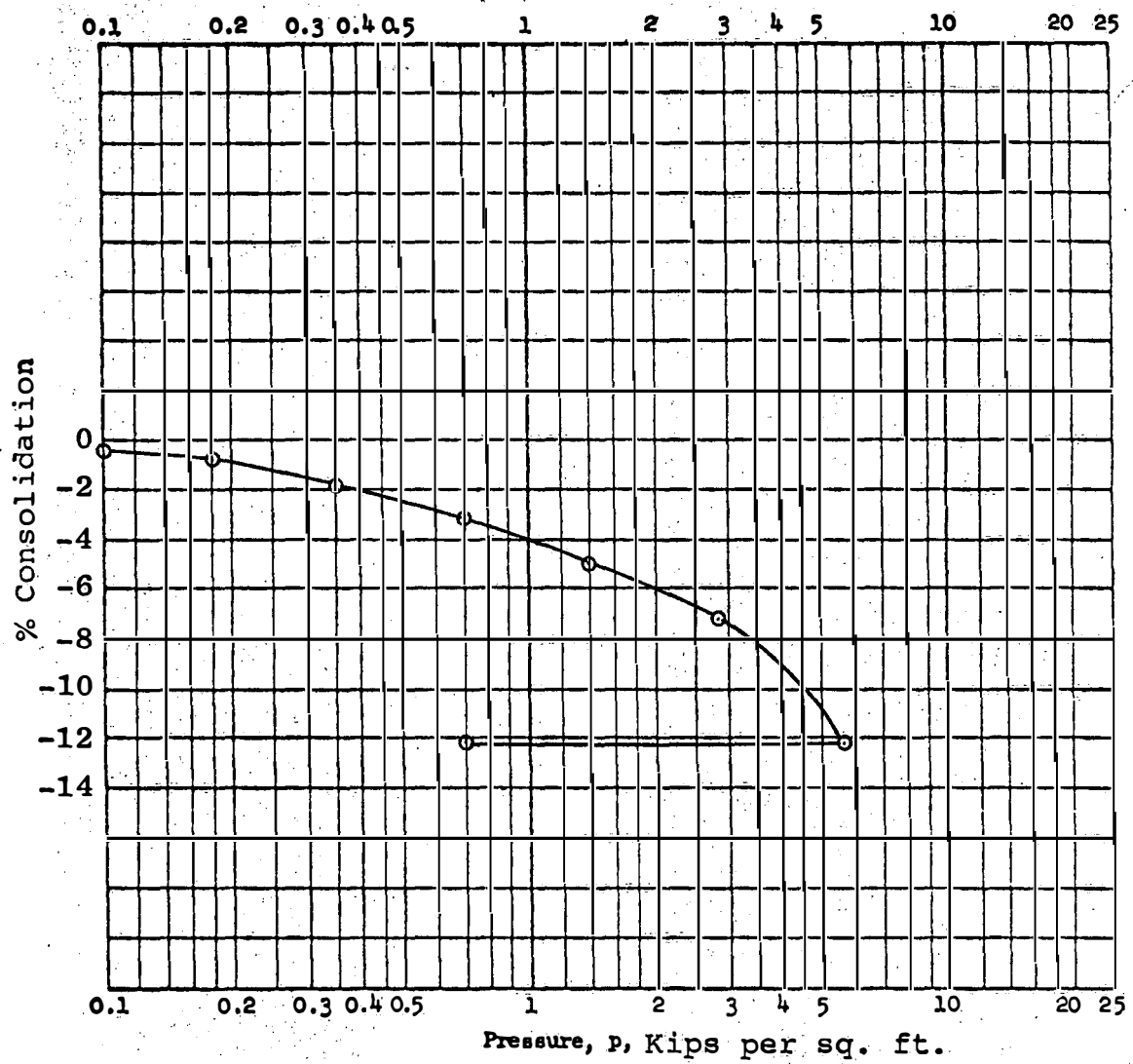
Plate B7



Type of Specimen: Undisturbed		Before Test		After Test	
Diam 2.40 in.	Ht 1.0 in.	Water Content, w_o	56.4 %	w_f	%
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o		e_f	
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	%	S_f	%
Compression Index, C_c		Dry Density, γ_d	82.0 lb/ft^3		
Classification ML		k_{20} at e_o =	x 10$^-$ cm/sec		
LL	G_s	Project	Kaopa Subdivision Unit 3B		
PL	D_{10}		Lone Star Hawaii, Inc.		
Remarks		Area	W.O. 176-B		
		Boring No.	B3	Sample No.	
		Depth El	24'	Date	5-1-74
		CONSOLIDATION TEST REPORT			

ENG FORM 2090
1 MAY 63

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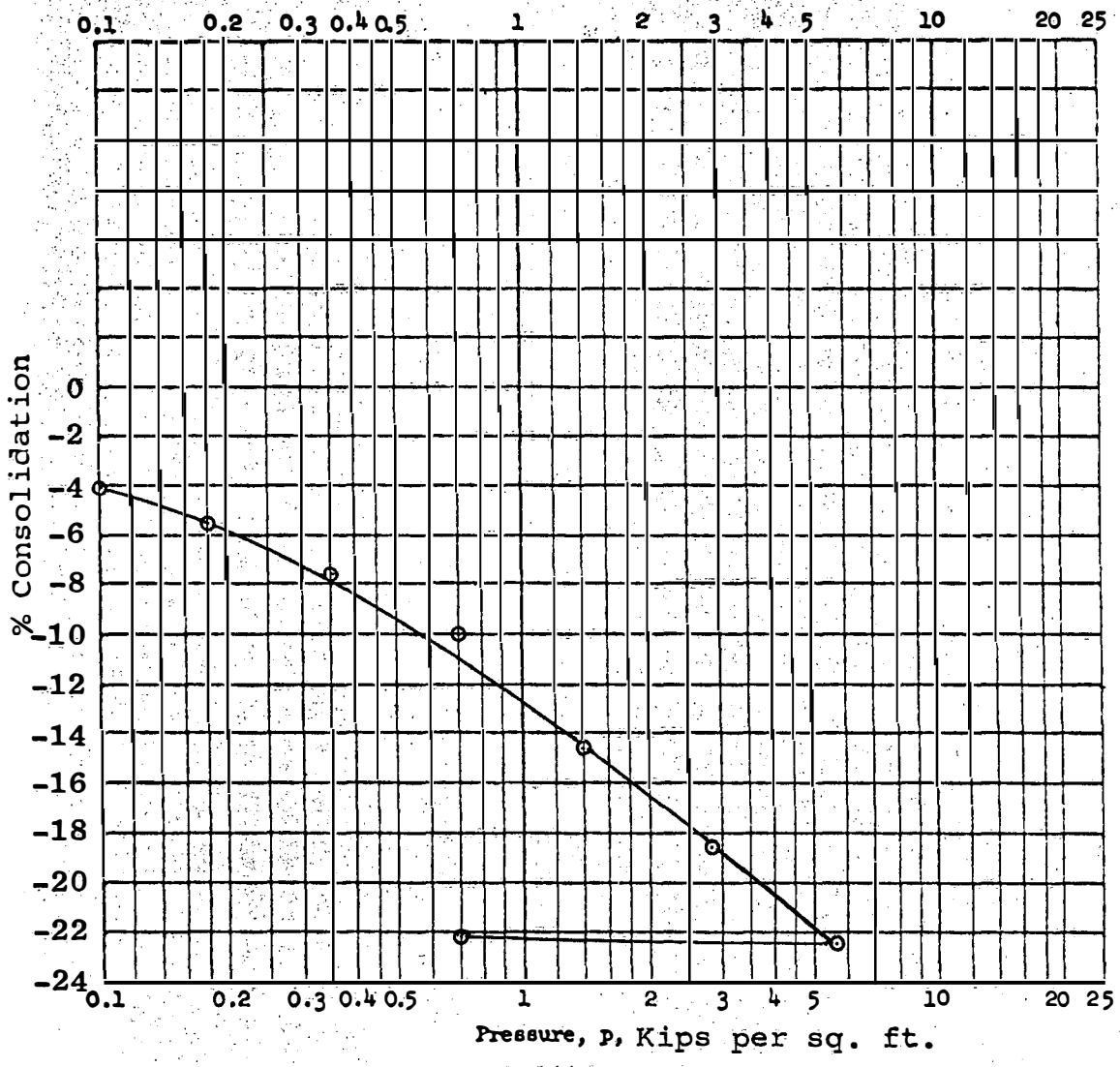
Plate B8



Type of Specimen: Undisturbed		Before Test		After Test	
Diam 2.40 in.	Ht 1.0 in.	Water Content, w_o	64.2 %	w_f	%
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o		e_f	
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	%	S_f	%
Compression Index, C_c		Dry Density, γ_d	60.8 lb/ft^3		
Classification ML		k_{20} at e_o =	× 10$^-$ cm/sec		
LL	G_s	Project	Kaopa Subdivision Unit 3B		
PL	D_{10}		Lone Star Hawaii, Inc.		
Remarks		Area	W.O. 176-B		
		Boring No.	B4	Sample No.	
		Depth El	9'	Date	5-2-74
		CONSOLIDATION TEST REPORT			

ENG FORM 2090
1 MAY 63

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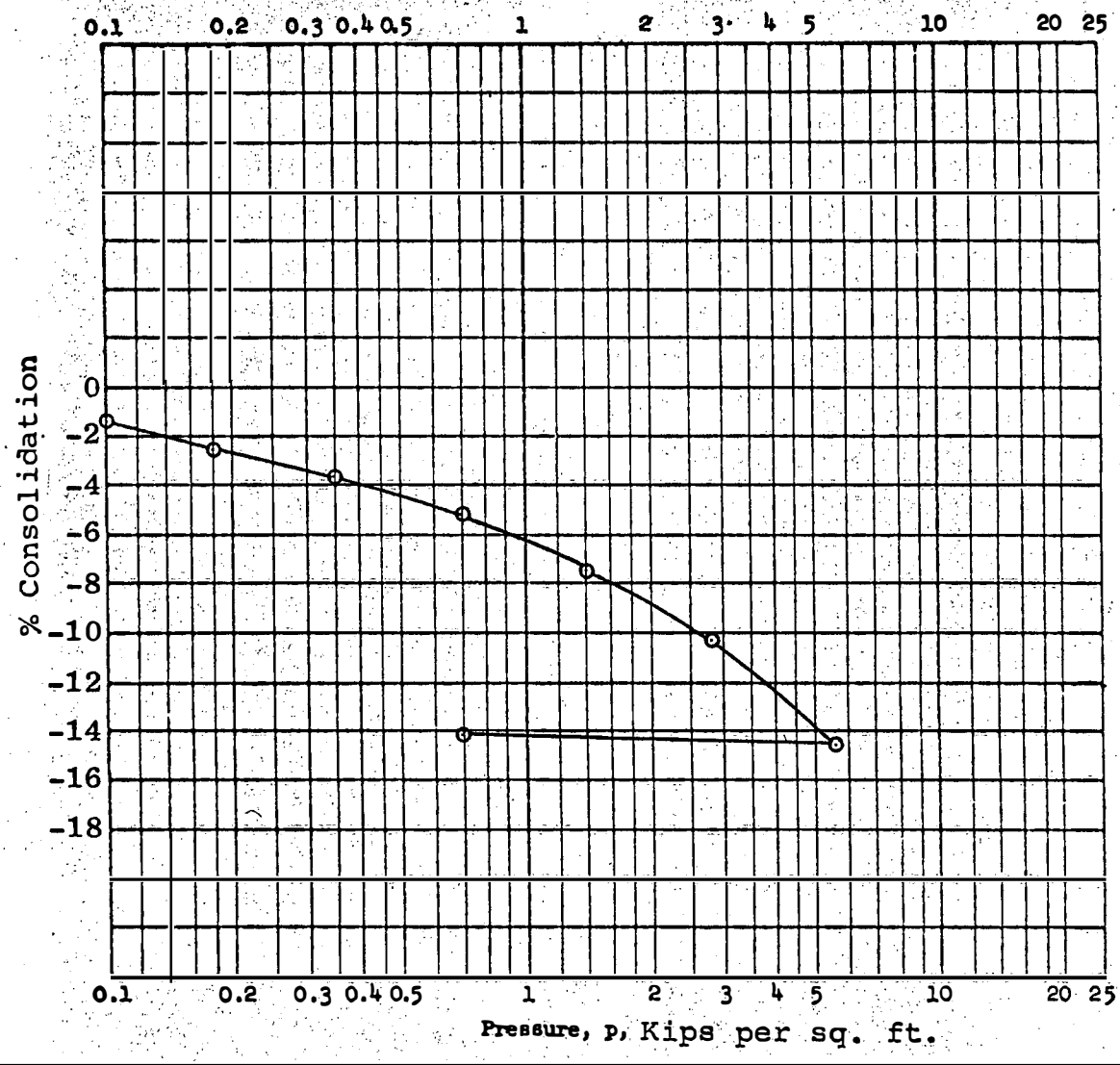
Plate B9



Type of Specimen: Undisturbed		Before Test		After Test	
Diam 2.40 in.	Ht 1.0 in.	Water Content, w_o	%	w_f	%
Overburden Pressure, p_o	T/sq ft	Void Ratio, e_o		e_f	
Preconsol. Pressure, p_c	T/sq ft	Saturation, S_o	%	S_f	%
Compression Index, C_c		Dry Density, γ_d	lb/ft^3		
Classification: ML		k_{20} at e_o =	× 10$^-$ cm/sec		
LL	G_s	Project: Kaopa Subdivision Unit 3B			
PL	D_{10}	Lone Star Hawaii, Inc.			
Remarks		Area: W.O. 176-B			
		Boring No.: B4	Sample No.		
		Depth / El: 13'	Date: 5-2-74		
		CONSOLIDATION TEST REPORT			

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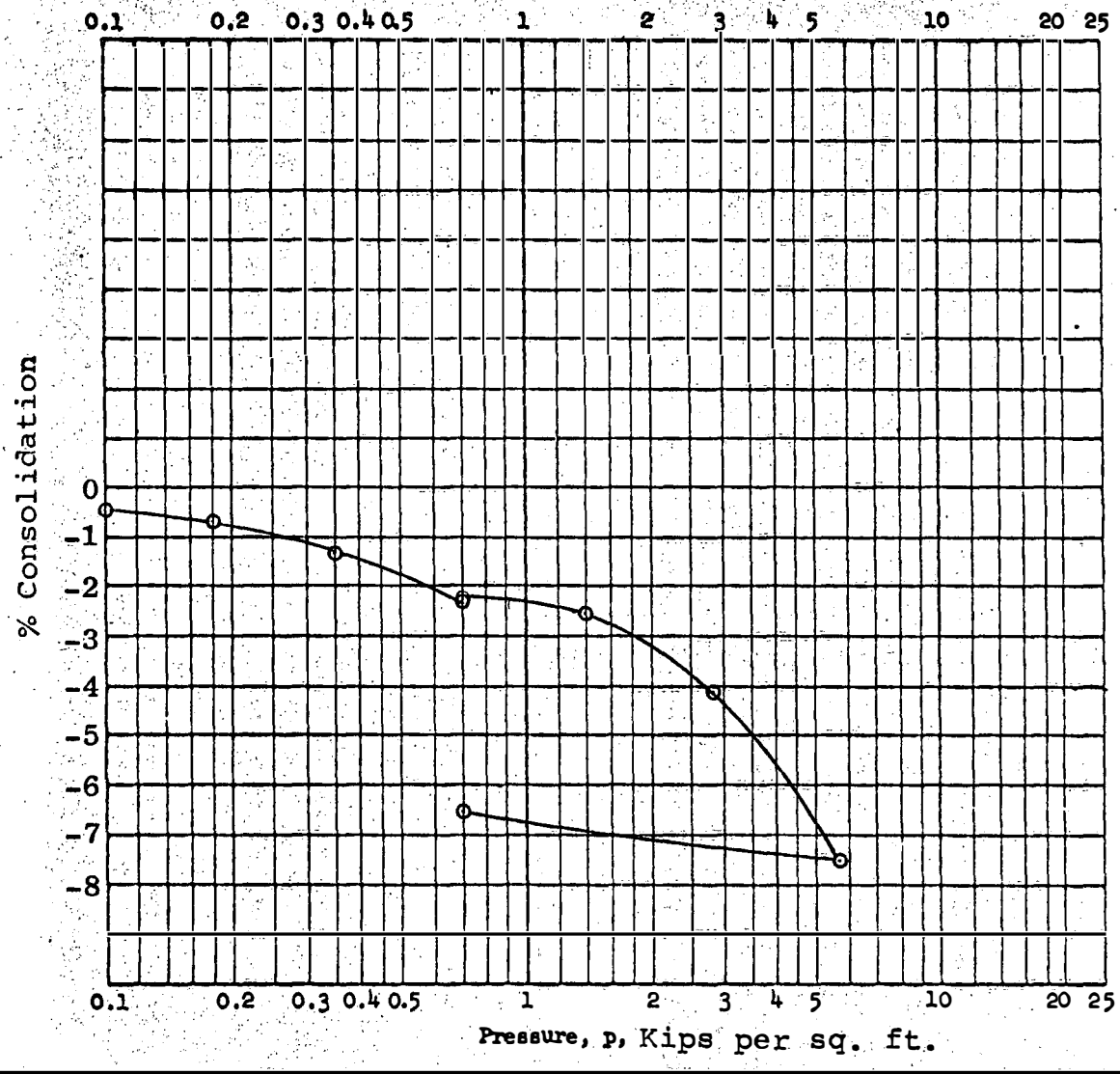
Plate B10



Type of Specimen	Undisturbed	Before Test		After Test	
Diam 2.40 in.	Ht 1.0 in.	Water Content, w_o	33.2 %	w_f	%
Overburden Pressure, p_o	T/sq ft	Void Ratio, e_o		e_f	
Preconsol. Pressure, p_c	T/sq ft	Saturation, S_o	%	S_f	%
Compression Index, C_c		Dry Density, γ_d	82.9 lb/ft^3		
Classification MH		k_{20} at e_o =	x 10$^-$ cm/sec		
LL	G_s	Project	Kaopa Subdivision Unit 3B		
PL	D_{10}		Lone Star Hawaii, Inc.		
Remarks Water added at 700 PSF		Area	W.O. 176-B		
		Boring No.	B4	Sample No.	
		Depth El	22'	Date	5-8-74
		CONSOLIDATION TEST REPORT			

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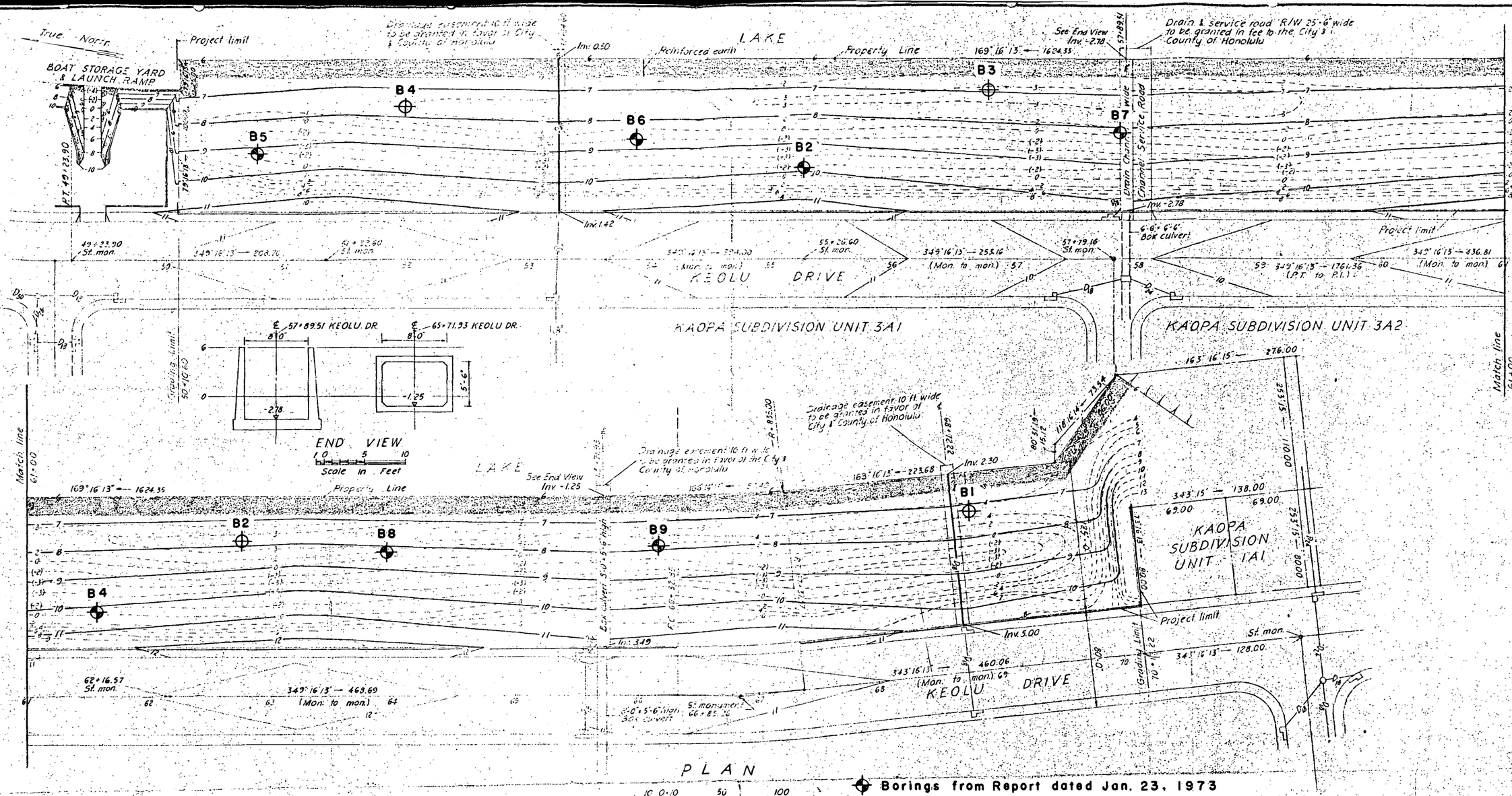
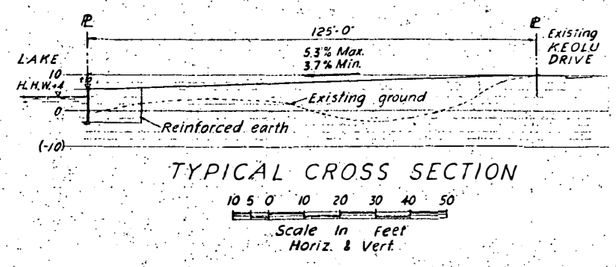
Plate B11





TYPICAL CROSS SECTION

10 5 0 10 20 30 40 50

Scale in Feet
Horiz. & Vert.

● Borings from Report dated Jan. 23, 1973

⊕ Borings taken May 1974

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION

DATE

APP'D | BY | BRIEF | DATE | REVISION

DESIGNED BY E.T. | DRAWN BY E.T. 1-24 | CHECKED BY D.K.J. | SUBMITTED BY | REVIEWED BY | APPROVED BY

DEPUTY TRAFFIC ENGINEER, DEPT. OF TRAFFIC — DATE

CHIEF, DIV. OF SEWERS — DATE

SUNN, LOW, TOM & HARA, INC.
ENVIRONMENTAL CONSULTANTS
HONOLULU, HAWAII

APPROVED BY:

CHIEF, DIV. OF ENGINEERING — DATE

ASST. CHIEF ENGINEER, BWS — DATE

KAOPA SUBDIVISION UNIT 3-B
KAILUA KOOLAUPOKO OAHU HAWAII

PRELIMINARY GRADING PLAN

ERNEST K. HIRATA & ASSOCIATES, INC.
Soils and Foundation Engineering
1236 South King Street Honolulu, Hawaii

W.O. 176-B

SHEET OF SHEETS DWG. NO.

FILE | POCKET | FOLDER | NO.